Translated from French

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54 Machine tool incorporating a clamping device.

72 Invention:

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The present invention concerns a machine tool of the kind including at least one spindle driven in rotation by a motor and equipped with a clamping device for tools or pieces to be processed. In particular, this machine, equipped with one or more spindles, can be used to carry out piercing, spot-facing, countersinking, tapping, boring, turning, screwing etc...

Furthermore, in the domain of portable tools, the device according to the invention may be incorporated in drilling machines, grinders etc.. and more particularly in so-called convertible drilling machines comprising adaptable accessories (tools plus tool casings) in a manner to form a new machine intended for another function such as sawing, sanding, turning, screwing etc...

Nevertheless taking into account certain especially interesting properties of the clamping device in particular with regard to its realisation and utilisation features it can still be used on multiple use household tools such as mixers, grinders, beaters etc.. in medical or dental equipment or to make independent and removable engine blocks used in separate or combined multiple-use machines such as for example those intended for processing timber.

There are already machine tools equipped with clamping devices called chucks which require a special key for blocking and unblocking. The use of these chucks is slow and the key may get lost and cause accidents if forgotten in the chuck. To remedy these inconveniences there are keyless chucks, called self-blocking, which are managed manually without any effort. These chucks which are less strong than the aforementioned ones have an overhang which is greater than that of the spindle bearings.

There are also motorised machine tools for multiple uses called convertible which are generally portable electric drills which transform into other machines such as saws, sanders etc.. by adding on adjustable accessories (tools plus tool casings) without a motor. In some cases this coupling is performed without disconnecting the chuck to form a new machine which is cumbersome, not very manageable and not very robust because of the significant overhang of the tools. In other cases the chuck is dismantled before attaching the accessory which is then placed on the tip of the spindle of the base machine. The ensemble thus obtained is more compact, has a better grip during use but the assembly time is lengthy, which makes the use of the machine annoying.

There is also a rapid accessory attachment device on the base machine of the drill type realised using bayonets which engage in oblong holes by a quarter rotation of the base machine. This assembly would be very rapid if it did not require the prior dismantling of the chuck. On the other hand the accessories need to have their own tool axes and bearings, which is particularly onerous.

The machine tool with an incorporated clamping device envisioned by the invention has as its aim in particular to remedy these inconveniences. According to the invention the machine tool is of the type which comprises at least one spindle turning on two bearings, driven by at least one rotating motor with or without the interposition of a transmission and equipped with at least one removable and interchangeable tool clamping device or pieces to be processed, tool casings equipped with guides and/or tool protectors, the said tool casings being removable and

interchangeable and comprising their own fixing device. This machine is principally characterised in that the device for clamping tools or the pieces to be processed comprise clamping jaws and is one whole and incorporated with the machine and in that the body of this device acts directly as a spindle and turns within the two spindle bearings.

According to a preferred arrangement of the invention the clamping device is placed near the front bearing of the spindle and more precisely in large part towards the interior of the latter while its means of manoeuvre such as a jaw clamping ring is preferably situated between the two bearings. These characteristics allow the realisation of a simpler machine with fewer mechanical parts, more robust and very compact whose clamping device is well protected inside a casing. It also results from this that the length of the overhang of the front extremity of the spindle on the clamping device side is much reduced and even less than the separation of the spindle bearings, and consequently the grip on the tools and the endurance are significantly improved.

According to another preferred characteristic of the invention the means of manoeuvre such as the clamping ring is realised by left hand feed tapping of the jaws and driven with or without the interposition of a transmission by the motor which transmits torque directly to the clamping jaws and not to the spindle. Thus a clamping device is realised which incorporates self-clamping where clamping is proportional to the torque resistance of the tools and which is easy to manoeuvre without necessitating a special key.

According to a preferred particular aspect of the invention the spindle or means of manoeuvring comprises an immobilisation device, for example a toothed part co-operating with a catch, intended by its temporary activation, to block it in reverse rotation and brake it in normal rotation in order for tools to be exchanged.

According to another particularity of the invention preferably combined with the preceding one, it is also possible to use a portion of the torque of the drive motor to turn in both rotation directions, the means of manoeuvring or the spindle, in such a way as to unclamp or clamp the tools thanks to the normal operation of the motor fitted with a rotation direction inverter and a speed or torque restrictor.

Of the two aforementioned particularities the process of changing tools is effected automatically and instantly, without any effort and without a special key, the time thus gained being very appreciable.

According to another particularity of the invention, the aforementioned immobilisation device is articulated on a moving bolt forming the fixing device of the tool casings equipped with guides and/or tool protectors, this bolt being activated, when freed by a lever, at the same time as the clamping device by a reaction of the latter on this immobilisation device.

It is therefore possible to transform the base motorised machine into a new one to carry out different work by adapting it with non-motorised accessories (tools plus tool casings).This is the

case in particular with convertible drills to which accessories are adapted in order to obtain a new machine such as a sander, a saw etc.

This adaptation of accessories comprised of tools and tool casings is effected simultaneously and immediately without the slightest effort and without necessitating the prior dismantling of any part whatsoever of the base machine tool or the use of special tools and allows a considerable saving of time. On the other hand, the accessories are of a simple construction and at a low cost price.

The machine tool with these characteristics may receive various material structures resulting from the following description. At the same time other particularities of the invention will be highlighted.

It will be assumed in this description that the machine tool is of the portable or fixed drill type, this type of machine constituting a preferred domain of application of the invention, without this nevertheless implying any limitations. The term tool machine is furthermore here understood in the most general sense and also encompasses fixed or portable turning spindle machines, household appliances, medical and dental equipment etc equipped with a motor and using interchangeable working tools.

In the attached drawings, provided as examples without any limitative intention, various realisations of the invention have been represented;
Figure 1 is a view in elevation of a first industrial realisation, showing a section through a plane passing along the longitudinal axis;
Figure 2 is a view in elevation of a variant, showing a section according to II.II of Figure 3.
Figure 3 is a transverse section, according to III.III of Figure 2;
Figure 4 is an electrical diagram;
Figure 5 is a longitudinal section according to V.V of Figure 6 of a second variant;
Figure 6 is a transverse section according to VI.VI of Figure 5;
Figure 7 is a view in elevation of a second realisation after a section along the longitudinal axis;
Figure 8 shows a variation of use of the preceding realisation;
Figure 9 shows a partial detail of this realisation;
Figure 10 is a longitudinal section according to X.X of Figure 11;
Figure 11 is a straight section according to XI.XI of Figure 10;
Figure 12 is a partial view in section of a variation;
Figure 13 is a longitudinal section according to XIII.XIII of Figure 14 of a third realisation;
Figures 14 and 15 are straight section according to XIV. XIV and XV. XV of Figure 13;
Figure 16 is a view developed according to XVI.XVI of Figure 15;
Figure 17 is a longitudinal section according to XVII.XVII of Figure 18 of a variation of the realisation;
Figure 18 is a transverse section according to XVIII.XVIII of Figure 17.

In a first industrial realisation represented at Figure 1 the machine tool according to invention is an electric portable drill whose spindle 1 turns in casings 2 and 3 through bearings 4 and 5.

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A clamping device 6 for tools similar to a traditional clamping chuck is built in to the drill inside casing 2 and forming an integral part of the machine due to the fact that the body of this clamping device acts directly as a spindle 1.

The clamping device located near the forward bearings and more specifically inside the latter consists of three cylindrical clamping jaws 7, arranged at 120 degrees, sliding along the slots of the spindle whose axes are inclined equally and concurrently with that of this spindle and each comprising a toothed external part 7a which forms a thread and screws using a means of manoeuvre such as a left-handed tapping ring 8, situated between the two bearings and force fitted onto the driving pinion 9 the teeth of which 9a engage with the drive pinion 10 of the electric motor 11. It would not be outside the scope of the invention to replace the electric motor with a completely different type of motor such as a pneumatic or hydraulic motor.

The direction of rotation of the motor 11 is such that the spindle 1 turns according to D (clockwise rotation, view from rear).

The external front extremity of the spindle 1 comprises a knurled part 1a and 2 flat sections 1b allowing it to turn either manually or using a flat key.

The incorporation of the clamping device with the drill allows a simplification of construction by reducing the number of mechanical parts and toleranced sides. in particular, the elimination of the need to fix the traditional chuck to the spindle either by a thread or by a taper improves fitting precision of the tools and consequently the precision of the work carried out. On the other hand the length L1 of the overhang of the front extremity of the spindle on the side of the clamping device is very small compared to traditional devices and even less than the distance L2 between the two spindle bearings. This is due to the new arrangement of the clamping device which is incorporated and integrated in the machine and the majority of whose parts are located between the two bearings and not outside these. Thus the clamping of the tools and the endurance of the machine are distinctly improved. Moreover, the machine is very compact and the inbuilt clamping device as well as its means of manoeuvre are well protected inside a casing.

Indicatively on a traditional drill equipped with a separate chuck the ratio of the lengths L1/L2 is about 1.73 when this same drill transformed and equipped with an inbuilt clamping device has its L1/L2 ratio reduced to only 0.33.

The opening of jaws 7 is effected by manually turning according to D spindle 1 using the knurled part 1a. As clamping ring 8 screws to the left, jaws 7 tend to separate according to E. After putting in place a tool, inverse rotation at D of the knurled part on the contrary draws jaws 7 closer together according to R which close the tool. during these operations the clamping ring 8 and the drive pinion 9 tend to remain fixed because of the inertia and friction of the transmission and the rotor of the motor 11.

The gripping of the tool by the jaws does not require a major manual effort because on starting up the drill, the transmission of the torque is effected by the drive pinion 9 through the clamping ring B which tends unceasingly to draw together the jaws and grip the tool. In effect as the clamping ring is threaded to the left the torque which operates according to D tends to unscrew this ring therefore to forcefully push according to R jaws 7 against the tool. The result is a self-gripping of the tool proportionate to its torque resistance.

The effectiveness of the self-gripping is determined by the value of the tapping step of the gripping ring 8. This step should not be too weak so that the ungripping is effected easily by hand. Nevertheless it is possible to use a flat key engaged on the two flat sections 1b and unblock the clamping device which might accidentally be too tightly clamped or jammed with a knock.

Figures 2 and 3 show a variant of the previous realisation the general arrangement of which remains the same and to which has been added an immobilising device of the spindle and an inverter of direction.

Spindle 1 is completed in its rear part by teeth 14 of which one side 15a of these teeth 15 is radial while the other opposite side 15b is inclined in relation to the first to thus form an intervening v-shaped space 16 the angle A of which is comprised between 10 and 40 degrees.

A lever 17 comprises a point 18 capable of engaging with one of the between teeth spaces 16 to immobilise the spindle and turns on an axis 19 force fitted over the casing 3 of the drill, this axis being approximately located on tangent T in the middle circle of teeth 15.

On the other hand the lever 17 comprises on the other side of the axis 19 an extension 20 on which two holes 21a and 21b have been drilled. Near these holes the casing 3 has been drilled with a hole 22 in which a bearing 23 slides, resting by means of a spring 24 on the extension 20 of the lever, the diameter of the bearing being slightly greater than that of the holes 21. This arrangement allows the lever 17 to be maintained in its two extreme positions; the position at rest where the bearing 23 is over the hole 21a, and the engaged position with the bearing over hole 21b. Thus a certain amount of effort is required to move from one position to the other. This is imposed by the bearing coming out of one of these holes.

The drill is completed by a push-button 26 electrical inverter 25 which is extended by a shank 27 coming into contact with the extension 20 of the lever 17. Figure 4 shows an electrical diagram of this inverter 25 with an electrical power plug 28, the armature 29 and the inductor 30 of the electric motor, the three-position control switch 31 and a resistance 32 allowing the voltage at the extremities of the motor to be reduced and to thus achieve a lower rotation speed and torque. It would not be outside the scope of this invention to replace this type of command by an electronic speed command more and more frequently used and allowing the achievement of an infinitely variable rotation speed from zero to maximum. It is provided that a shank 33 attached to a catch 31a of the switch 31 includes notch 33a which allows the shank 27 of the inverter 25 to slide when the switch 31 is at rest; also shank 27 includes a shoulder 27a in a manner to allow the free-functioning of the switch 31 when the inverter 25 is at rest. This results in a mechanical security

link between the switch and the inverter which prevents them being activated simultaneously and therefore prevents any risk of a short-circuit. It would also have been possible to provide electrical safety by adding supplementary contacts to the inverter which would cut the electrical circuit of the switch.

By pressing the push-button 26 of the inverter 25 one initially causes the lever 17 to pivot and this pushes ball 23 outside hole 21a. As soon as the neutral point has been passed and the ball is settling into hole 21b the lever engages in a space between the teeth 16 or rests against a tooth 15 which it jumps as soon as the motor is started in reverse at the end of the run of the push-button of inverter 25. In effect this branches the inductor 30 in reverse but resistance 32 limits the voltage to the capacity of the motor and therefore the rotation speed and the torque. Spindle 1 being blocked by lever 17, the motor drives the pinion 9 according to the inverse direction of D, the clamping ring 8 screws and tends to separate jaws 7. Thus the tools are automatically and quickly unblocked effortlessly and without having to use a special key.

By releasing push-button 26, inverter 25 returns to its normal position but lever 17 remains in the engaged position with jaws 7 open. It is then possible to place a new tool between the jaws and by pressing on switch 31 the motor starts rotating normally according to D and drives pinion 9 as well as clamping ring 8 which draws jaws 7 towards the tool. The latter is clamped and point 18 disengages once the clamping coupling applies sufficient force according to I to turn the lever 17 which places itself in the resting position with hole 21a opposite ball 23. Spindle 1 being totally released, it becomes possible to use the drill. As previously the clamping device is self-gripping but a plastic plate 34 with a rubbing co-efficient that is sufficiently high is placed inside a hole 1c of the spindle and pressed against pinion 9 by a spring and constitutes a friction braking means avoiding unexpected unclamping of tools caused by vibrations during work. The use of the motor energy allows instant clamping and unclamping of tools without any effort and without requiring a special key. On the other hand the reduction in speed and of the motor's coupling whether by a resistance or by an electronic device or by any other means adapted to the type of motor used avoids claming and unclamping which is too abrupt and the overloads they may impose at the end of run while facilitating the use of the machine for fine work.

Figures 5 and 6 show a new variant of portable drill comprising an impact device and intended to carry out heavy work, particularly in concrete.

The components of the clamping device remain identical to the previous machine except spindle 1 which comprises on one rear side perpendicular to the axis a toothed part 38 whose teeth have a radial face passing through the longitudinal axis and another face inclined in relation to the first and forming several right-handed helices.

The impacting hammer 39 concentric to the spindle slides on the two fixing screws 40 of the casing and comprises on its front part saw teeth 41 facing those of the spindle. A flat spring 42 controlled by the button 43 rests the impacting hammer 39 on the spindle 1 through toothed part 38 and 41 in such a way that for one rotation according to D of spindle 1, the hammer is pushed

back by the inclined faces of the teeth and violently strikes the spindle 1 after the passage of each tooth, axial free play j1 allowing a slight sliding towards the front of this spindle at each blow.

Two small springs 44 return the hammer 39 into its resting position against the casing 45 and the ring 46 in a manner to reduce axial free play j2 of the spindle under normal operation without impact.

This conception of the impact device is simple and economical and is activated by pushing the button 43 forward, when toothed parts 38 and 41 engage with each other.

This drill does not comprise any external means for manoeuvring the clamping device except a direction inverter because the impact device allows this manoeuvre to be carried out. Its use is as follows:

The engagement of the impact device by the button 43 and the activation of the inverse rotation of the motor and consequently of the pinion 9 at the inverse of D for a brief instant allowing clamping jaws 7 to be separated because spindle 1 cannot turn inversely due to the radial and axial faces of the teeth 38 and 41 which are engaged. The tool is unclamped and may be changed.

The start of rotation according to D (normal direction) of pinion 9 on the other hand draws jaws 7 together as teeth 38 and 41 engaged prevent the spindle 1 from turning and once these jaws have gripped the new tool the clamping torque increases until the teeth 38 of the spindle escape on the inclined face of the fixed teeth 41 of the impacting hammer whose repeated impact sound indicate that the tool is sufficiently gripped. As previously the clamping device is self-gripping and it can easily be noted that during the use of the drill with its impact function a tool gripping torque is permanently exercised which avoids any untimely unclamping due to vibrations of the tool used during impacting.

According to another industrial realisation of the invention represented at Figures 7 and 8, the machine tool is a sensitive bench drill.

In casing 50 of the drill, slides the spindle 51 comprising a gear 52 on which the control pinion 53 engages, connected to the descent lever and to the return spring which are not shown.

Spindle 54 which is partially tubular turns on two rollers 55 and 56 inside the spindle carrier and comprises, in its lower section, a tapered axial hole *illegible* and at least three inclined holes 54b in which slide the gripping jaws 57 each of which have a toothed part 57 *illegible* directed towards the interior and constituting the gripping device built into the spindle. The control of the jaws 57 is effected by a left-handed tapered screw 58 placed inside the spindle and centred by shoulder 54c.

From pulley 59 mounted on the casing 50 by means of double-roller 60, spindle 54 is driven by a grooved shaft 61 fastened to the pulley 59 and sliding in another hollow shaft 62 with internal grooves coupled to tapered screw 58. This disposition allows the grooved driving shaft to be

incorporated inside the spindle and not extending above the driving pulley, as the height of the machine is thus more reduced.

Ball bearings 63 position the grooved shaft and absorb the reactions of the tapered shaft 58. On the other hand an elastic bearing 64 consisting of an undulating spring limits the return of the spindle carrier return 51.

One also notes in this realisation that the built-in clamping device simplifies the construction of the machine by reducing the number of parts and toleranced sides and eliminating fixation either by a taper or by threading the traditional chuck on the spindle. As in the first realisation it is noted that the overhang L1 of the external extremity of the clamping device in relation to the axis of the lower bearing is very much reduced and lower than the distance between centres L2 of the bearings of the spindle. Comparatively a traditional machine has an L1/L2 ratio greater than 1.5 whereas a machine with a built-in clamping device according to the invention sees this ratio drop below 0.4, which considerably improves the grip on tools and the precision of the work performed.

As in the first realisation the opening of the clamping jaws 57 is effected by manually turning according to D the lower end of the spindle 54, the jaws tending to screw onto the tapered screw 58 kept appreciably fixed by the inertia of the transmission. The closure of the jaws on the tool 65 is obtained by the inverse rotation of the spindle.

When the drill is started the torque transmission is achieved between the pulley 58 and the tool 65 by the grooved shaft 61, the hollow shaft 62, the tapered screw 58 and the jaws 57. In effect, the spindle 54 is not directly linked to the pulley 59 and one obtains a self-gripping clamping device because if the resistant torque increases, the tapered screw 58 tends to push therefore to further tighten the jaws.

The manoeuvring of this clamping device only requires minimal effort, nevertheless some holes 54d allow a shank to be used to unblock it in the unlikely event it jams.

The use as previously of an immobilisation device for the spindle and the motors energy to manoeuvre the clamping device also facilitates the use of the machine.

After completely opening the clamping jaws, it is possible to use tapered tailed tools 69 which are pushed into the tapered hole 54a of the spindle and whose tenon 69a engages in a slot 58a cut into the tapered screw 58. Thus the tool 69 is centred directly in the spindle 54 by the tapered hole 54a and is driven directly by tapered screw 58 on its tenon, the clamping jaws no longer having any function (Figure 8).

As shown at Figure 9 it is also possible to directly connect spindle 54 to tapered screw 58 using an automatic coupler realised simply by balls 70 placed inside holes 54e of the spindle and engaging in internal grooves 58b of the tapered screw at the placement of the tool 69 in a manner

that the greater part of the torque is transmitted by the tapered housing of the tool. Edges 54f keep the balls at rest and prevent their loss.

The extraction of tool 69 is achieved either by raising the spindle carrier 51 by compressing the elastic stop 64 (Figure 7) or lowering the grooved shaft 61 with the aid of cam 66 connected to the lever 67 with a spring 68 returning this shaft to rest (Figure 8); this having the effect of butting against the extension 61a of the groove shaft of tenon 69a of the tool which is disengaged from the tapered hole 54a.

It is easily noted how this arrangement allows the use of tools with a cone shaped tail without having to dismantle the chuck as in traditional drills and thus to save considerable time. Furthermore the extraction of tools does not require any accessory tools such as a taper tool and it is possible to use on cone shaped tail tools the machine's inverse rotation (for example, tapping).

Figures 10 and 11 show a multiple spindle variant of the preceding realisation more particularly adapted to machine transfers used to drill countersink tap, bore...

Spindle 71 comprises at one extremity a tapered bore 71a and turns on two bearings 72 and 73 inside the spindle carrier 74 maintained, together with other spindle carriers of the unit not shown, by two plates 75 and 76. This spindle is driven by means of a cascade of pinions 77, 78 by the motor 79 on which a motor power supply interruption device 80 is mounted once this has effected a certain number of revolutions in reverse, this device consisting of a simple revolutions counter or a reference screw controlling the supply contactor.

The clamping device consists of a cone-shaped pincer 81 comprising at least three jaws 81a recalled elastically, one taper sufficiently large and one extraction spring 96 preventing this pincer from ever jamming. A clamping socket 82 which screws onto the extremity of the spindle (right-handed) grips pincer 81 in the tapered hole 71a of the spindle and comprises on its periphery teeth 83 forming a ratchet wheel.

A catch 84, retrieved by an interchangeable calibrated spring 88 or regulator is articulated on an axis 85 riveted on a sliding plate 86 attached with shoulder screws 87 through oblong holes 86a and comes into contact with teeth 83 when the said plate is moved according to T. A retaining tip 84a and a pin 89 attached to plate 86 prevent the catch 84 from touching the teeth 83 in the rest position, that is when the said plate is moved to its limit at the inverse of T.

The plate 86 sliding control device, not shown, may advantageously be realised by a solenoid with a release spring or by any other mechanical, hydraulic or pneumatic means.

The advancement of the tools is determined as generally in all transfer machines by the movement of the entire unit along slides.

Tools of a unit are changed in the following manner:

An empty tool carrying plate 90 and another one 91 equipped with new tools 93 pre-adjusted using screws 94 are inserted between the pieces to be processed and circulate with the latter on the work table. At each passing before a non-relevant unit, stops placed on each plate prevent the unit from operating by cutting its power supply and avoiding any accidents.

The passing of the first empty plate 90 past the unit where tools are to be changed, a control stop activates a switch which determines the following process:

Advancement of unit – engagement of catches 84 by displacement of plate 86 according to T and coupling of switch device 80 – start-up of inverse rotation of spindles 71, the effect of which is to release tools 92 as the clamping sockets 82 are blocked in rotation by catches 84 - cutting of motor power supply by the switching device 8 - after a certain number of revolutions (2 to 3 for example) in a manner to avoid completely unscrewing the sockets 82 - return of the empty unit, with the worn tools 92 remaining in the corresponding housings 90a of the plate 90 which the elastic or magnetic elements 95 hold in place.

During the next cycle it is the equipped plate 91 which presents itself before the unit and a control stop of a switch starts a new process:

Advancement of unit, catches 84 having remained engaged – start-up of normal rotation according to D of clamps 71, the effect of which is to grip new tools 93 as clamping sockets 82 are braked by catches 84 which jump on the inclined faces of the teeth 83 when the tool gripping torque exceeds the action of spring 88 – cutting of motor power supply by switching device 80 returning to zero – return of the unit equipped with new tools 93 ready to machine the pieces which follow plate 91 and return of plate 86 then catches 84 to rest.

It is easily noted that this tool assembly principle allows considerable time saving by the simultaneous changing of all tools of a unit without stopping the entire transfer machine, the time required for this change being very short and equivalent to that of two basic machining cycles. The productivity and profitability of the machine are considerably improved.

The absence of self-clamping allows this clamping device to be used for inverse rotation operations such as tapping or screwing including on machine tools that are portable or fixed, single or multi-spindle and equally for tools and pieces to be processed such as for example cutting lathes where a source of energy and special servo-commands are no longer required to activate clamping devices as in traditional machines (pneumatic chucks, for instance).

It would not be outside the scope of this invention to place the sliding plate 86 inside the machine as in, for example, above the pinions, with the clamping socket being replaced by a screw that crosses the hollow spindle and being screwed into the pincer and/or to replace catch 84 by another braking means such as a tapered friction pad 97 which is mounted with a spring 98 on the sliding plate 100 activated by at least one hydraulic piston 99 and which co-operates with the external taper *illegible* of socket 82 (Figure 12). These variations of realisations enable a mechanical ensemble which is better protected and which operates more smoothly.

In certain applications, tools may be accompanied by tool casings providing guidance and/or protection to these tools. This is the case of so-called convertible drills which transform into other machines by the addition of accessories without a motor consisting of a tool with a tool casing and where the device according to the invention is particularly convenient for the simultaneous attachment of these tools and tool casings.

Figures 13 to 16 show such a device applied to a convertible drill transformed into a grinder.

As in the previous realisations, spindle 101 turns on two bearings 104 and 105 of casings 102 and 103 of the drill and forms the main body of the clamping device 106 realised by at least 3 clamping jaws 107 inclined at an angle between 10 and 20 degrees more specifically close to 15 degrees, each comprising teeth 107a which co-operate directly with the left-hand tapered tapping 108 of the driving pinion 109, the said taper being very similar to that which forms jaws 107. This pinion 108 is guided along its front aspect by a ring 110 forced or fixed by screws onto spindle 101 and comprising teeth 111 with parallel faces easily milled forming inter-teeth v-shaped spaces 112 at an angle between 10 and *illegible* degrees determined by the number of teeth. This ring 110 may also be split and adjusted with a certain grip on the spindle to slide under a determined torque and thus realise a torque limiter.

Concentric to the ring 110, situated between the two bearings of the spindle and inside the casing 102, is situated the tool casing fixing device realised by a ring 115 in plate steel which comprises at least two bolts 116 rendered elastic by cuts 117 and passing through slots 118 made in the side walls of the cavities 119 of the casing 102 of a given distance A from the bottoms 120 of these cavities, these bottoms being situated on the same plane at right angles to the axis of the spindle 101. The seal from the exterior is ensured by a quite limited amount of free play of bolts 116 in slots 118 and finished if appropriate with felting.

On fixing ring 115 is articulated a catch 121 comprising at one end a point 122 and at the other a spiral cam 123 which rolls on the cylindrical part 109a of the pinion, with an elastic washer 124 braking the movements of this catch.

A blocking lever 125 turning on one of the fixing screws 126 of the casing 102 at its internal extremity bent back 125a which engages behind shoulders 127a or 127b of the fixing ring 115 in a manner such as to bolt it. A spring 128 keeps this lever engaged.

The overall device for clamping and fixing tools and tool casings is in spite of everything quite inexpensive as the parts are easy to machine and some are made out of a cut metal sheet.

Accessory 130 which in this case is a grinder, comprises principally a protective casing 131 in light poured alloy or sheet metal cut and stamped and a cover 132 articulated on an axis 133 and closed by an elastic latch 134. Fixing clips 135 of the protection casing 131, in equal number to that of the cavities 119, situated on the same plane and of a thickness appreciable equal to distance A, are located at the bottom of the said cavities behind the bolts 116; these fixing clips

as well as the cavities, obtained directly from grinding or cutting, are precise enough to ensure the tool casings are centred correctly without requiring expensive machining thanks to the elasticity of the fixing bolts.

The tool in this case is a grinder 138 attached by a hollow head screw 140 on the axis 139 whose cylindrical tail 139a is of a diameter slightly lower to that of hole 101a of the spindle which determines the maximum capacity of the clamping device. An approximate centring of axis 139 is achieved with sufficient free play by the head of the screw 140 in a groove 132a of the cover 132 and by the tapered bore 143 of protection casing 131 preferably tapered with the peak of the cone placed on the side of the tool in such a manner that the tool is constantly associated with its tool casing when it is not used and so that the assembly of complete accessories on the base machine is simple and very quick.

Other elements of the tool casing such as guides, means for fixing to the bench etc are not shown. This is also the case with the drill motor rotation direction inverter. To use the machine only as a drill tools are unclamped and clamped in the following manner: using the inverter the motor is briefly started in reverse and pinion 109 turns at the inverse of D, the effect of which is to turn according to D the spiral cam 123 which engages point 122 of catch 121 in an inter-tooth space 112 of ring 110 therefore blocking spindle 101; pinion 109 continues to turn and its tapered tapping 108 tends to distance jaws 107 and to release the tool which is in place. On the other hand, after having put a new tool in place and when restarting the motor in its normal direction (spindle turning according to D), pinion 109 tends to draw jaws 107 together and to grip the tool, with catch 121 disengaging as soon as the braking torque provided by the elastic washer 124 is exceeded. In use, the clamping device 106 is self-gripping like in the first realisation and the tapered tapping 108 of the pinion rests against the tapered part 101b of the spindle which tends to brake it and avoid any accidental unclamping.

To adapt an accessory to transform the drill into a new machine such as a grinder if appropriate, one opens the tool clamping device as well as the tool casing fixing device by pressing simultaneously block leaver 125 and on the direction inverter, the effect of which is to engage catch 121, to separate the jaws as much as possible and to turn the fixing ring 115 according to the inverse of D by the reaction of the said catch on the latter.

One presents the drill on the accessory, with the fixing clips 135 fitting into the corresponding cavities 119 and the tail of the axis of the tool 139a in the hole 101a of the spindle because of its centring in its tool casing and its tapered tail 139b.

Normal start-up of the drill according to D in the first instance allows the jaws 107 to be clamped around the said axis tail 139a and when the torque transmitted by catch 121 is sufficient, to turn the fixing ring 115 according to D, with bolts 116 immobilising fixing clips 135 of the tool casing. On completion of clamping catch 121 disengages from boss 141 of casing 102 and retracts, thus releasing toothed ring 110 and consequently spindle 101 while the blocking lever 125 blocks the fixing ring 115 with its turned-back extremity 125 *illegible* and shoulder 127

illegible. This assembly operation is carried out in an instant and the machine is ready to be used again.

Dismantling is also instantaneous and follows the reverse process: one presses simultaneously on the blocking lever 125 and on the direction inverter which engages catch 121, releases jaws 107 and frees fixing ring 115 which turns in the opposite direction to D, thus disengaging fixing clips 135. The drill is therefore separated from its accessory and is available for further use.

It should be noted that the tool or tool carrier can be changed without changing the tool casing (for example when changing grinder) by proceeding as for the drill except without pressing on blocking leaver 125 and having opened cover 132. Screw 140 and two flat sections 142 on axis 139 enable the tool on this axis to be changed.

Figures 17 and 18 show a variant of the preceding realisation in which the front casing 152 comprises a machined cylindrical part 154, concentric to the axis of the spindle and intended to centre the tool casings 115 by a bore 156. On the other hand pinion 159 is a part of spindle 151 and consequently the direct driving of the latter suppresses the self-gripping function of the jaws 157 and allows the machine to be used in both rotation directions. The manoeuvring of jaws 157 is carried out with the assistance of a right-hand tapped ring 158 comprising a fine external toothing 160 and an internal groove 158a enabling the jaws to be separated to their maximum limit. A catch 161 with multiple teeth which enables the tapped ring 158 to be blocked by the teeth 160 is articulated on a cam 163 which is concentric to the said ring and whose inclined ramps 164 control the exit of several bolts realised preferably by bearings 165 sliding along holes 166 of the casing 152 and coming to lodge in an internal groove 167 of the tool casings in such a way as to attach them to the machine. In the absence of a tool casing the bearings 165 are arrested by edges 166a set on the external extremity of the holes and a snap ring 168 maintains all the parts in place.

Catch 161 is kept in its two extreme positions – at rest and engaged – by a plate spring 162 riveted on cam 163 whose extremity lodges in two cone-shaped cuvettes 161b milled into the catch. At rest, tip 161a of the catch, positions itself behind boss 170 of casing 152 in such a way as to bolt the cam when it releases the bearings which fix a tool casing.

The engagement of catch 161 is carried out by means of a bevelled shank 171 controlled by button 172, with a spring 173 returning it to rest. This shank comprises at its rear extremity a teat 174 which can slide in a groove 175 of limited length of the direction inverter 176 of the machine motor, in such a way that the said inverter can be activated without acting on a bevelled shank where the activation of the latter (according to I) compulsorily sets the inverter to the reverse direction position (according to I). Furthermore near the bevelled extremity of the shank 171 a lug 177 fits into a notch 178 of the cam in such a way as to prevent it from rotating while the shank 171 is kept engaged. The operation of this device for clamping tools and fixing tool casings is similar to the preceding one. Unclamping of a tool is affected by pressing steadily on button 172 which engages catch 161 and the reverse direction, with tapped ring 158 being blocked by the teeth of the said catch. Brief start-up of the motor which turns the spindle 151 in

the inverse of D enables the jaws 157 to be separated. By setting the inverter to the normal direction position (according to M) the motor drives the spindle according to D and then re-closes jaws 157 until the clamping torque is sufficient to disengage spring 162 of cuvette 161b from the engaged position.

Similarly the unbolting of a tool casing is affected in the same way but by releasing button 172 after pressing on it in such a way that lug 177 does not prevent cam 163 from turning under the effect of the reaction torque of catch 161.

This arrangement allows accurate centring of accessories and tool casings which can turn in relation to the base machine, which is particularly advantageous for angle gear boxes, screwing machines or tappers and where the option of two operating directions is also useful. In the event where the tool casing is not to turn in relation to the machine, a lug (not shown) of the tool casing lodges itself in the cavity 179 of the front casing 152.

It is obvious that the present invention is not limited to the realisations described and that one can add to these numerous variations of execution. In particular the various technical means (clamping of tools, fixing of tool casing, motor controls, means of manoeuvre) described with respect to a particular solution may be adopted in other solutions and vice versa.

On the other hand while essentially about tool clamping the invention undoubtedly without any difficulty allows the clamping of parts to be worked, of utensils etc. It is also possible to use in the place of tool casings one or more larger machines without a motor to which a common motor can be adapted equipped with the fixing and clamping device according to the invention, as in the case of a multiple-function woodworking machine.

Translated from French

SUMMARY

According to the invention the machine tool is of the type which comprises at least one spindle turning on two bearings, driven by one rotating motor with or without the interposition of a transmission and equipped with at least one removable and interchangeable tool clamping device or pieces to be processed and, if applicable, tool casings equipped with guides and/or tool protectors, the said tool casings being removable and interchangeable and comprising their own fixing device. This machine is remarkable notably for the following characteristics taken separately or in combination:

1- The device for clamping tools or pieces to be processed comprises clamping jaws and is integral and incorporated with the said machine, with the body of this device operating directly as a spindle and turning in the spindle bearings.
2- The clamping device is located near the front bearing of the spindle;
a- The clamping device is partially inside the front bearing of the spindle;
3- The incorporated clamping device comprises at least three clamping jaws with a toothed part co-operating with a means for manoeuvring and sliding along spindle bores whose axes are inclined equally and concurrently with that of this spindle;
a- The inclination of the bores of the clamping jaws is comprised between 10 and 20 degrees, and more precisely appreciably equal to 15°;
4- the clamping device comprises a tapered pincer centred in a hole of the spindle of the same taper and comprising at least three clamping jaws activated by an elastic means;
5- The overhang length of the spindle at its front extremity on the clamping device side is distinctly lower than the distance between the two spindle bearings;
a- the ratio between the length of the overhang of the front extremity of the spindle and the distance between the two spindle bearings is comprised between 0.2 and 0.9 and more precisely, in the vicinity of 0.4.
6- The clamping device comprises a means of manoeuvre of the clamping jaws comprised principally of a thread and is activated either manually or by the drive motor;
a- the means of manoeuvre is placed in the vicinity of the front bearing of the spindle;
b- the means of manoeuvre is placed between the two bearings of the spindle;
c- the thread of the means of manoeuvre has a taper which is appreciably equal to that which forms the inclination of the clamping jaws;
d- the means of manoeuvre is comprised of an internally tapped clamping ring;
e- the means of manoeuvre is comprised of a threaded clamping screw;
7- The clamping device comprises a braking means interposed between the spindle and one of the elements of the means of manoeuvre;
a- the braking means is realised by a friction device;
b- the braking means comprises a pad realised in material of a good rubbing coefficient and located preferably in a housing in the spindle, with this pad then being pushed by a spring against one of the elements of the means of manoeuvre;
c- the braking means is realised by a tapered centring of one of the elements of the means of manoeuvre on the spindle;

8- The machine tool comprises an external rotation driving device of the spindle to manoeuvre the clamping device.
a- the external extremity of the spindle is partially knurled to turn the said spindle manually;
b- the spindle comprises on its external extremity at least two flat sections or a hole allowing the use of a flat key or a shank to unblock the clamping device.
9- The spindle comprises on its front extremity and at the clamping device an axial tapered hole to receive the tools or tool holders with tapered tails.
10- The means of manoeuvre such as the screw comprises a countersunk slot in which the tapered tail tool or tool holder tenon can be lodged.
11- The transmission shaft of the spindle comprises at its extremity on the tool side, an extension or a teat to eject the tapered tail tools, this operation being achieved by a penetration that is relatively greater than this shaft in the spindle;
a- The spindle comprises an elastic rest stop capable of being compressed to allow the said spindle a supplementary ascent and a greater penetration of the transmission shaft.
b- The transmission shaft comprises a cam with a feed lever intended to make it penetrate further into the spindle, with a spring resetting it at rest.
12- The spindle comprises a coupling of the locking type in order that it may be directly temporarily coupled to the means of manoeuvre.
a- The locking is comprised of bearings whose engagement in grooves is directly commanded by the tail of the tool when it is put in position.
13- The means of manoeuvre is directly coupled to the transmission of the motor in a manner to receive the motor torque;
a - the means of manoeuvre comprised of a tapped ring is fixed by banding to the drive pinion receiving the torque;
b - the means of manoeuvre is directly tapped in the bore of the spindle drive pinion ;
c- the means of manoeuvre comprises a grooved sliding shaft allowing simultaneously the transmission of the torque and the descent of the spindle;
d- the means of manoeuvre comprises a left-hand thread in a manner to close the jaws when normally driven by the motor;
14- The spindle comprises a part that is toothed or grooved and that is intended to immobilise it, with the means of manoeuvre then being directly coupled to the motor;
a- the toothed part has one of its inter-tooth faces inclined in relation to the other according to an angle comprised between 10 and 40 degrees;
b- the toothed part is realised on a ring that is separated and fixed on the spindle either by an adjustment device or a screw;
c- the toothed part is realised on a separate ring, split and elastic, of a diameter lower than that of the spindle in a manner to close it with a certain force;
d- the teeth of the toothed part are directed axially towards the rear and comprise a radial face passing through the longitudinal axis, with the other face inclined in relation to the former to form several right-hand helices.
15- The spindle possesses a certain axial free-play allowing its longitudinal displacement under the action of an impacting hammer, with a means being provided to reduce this free-play when the hammer is in the rest position;

a- the hammer is mobile axially, kept in rotation and concentric to the spindle and comprises on its front face axial teeth which co-operate with the axial teeth placed on a rear face of the spindle while the said hammer is attached to the spindle by a spring for an impact function.
16 – The means of manoeuvre comprises a part that is toothed or grooved and that is intended to immobilise it, with the spindle then being directly driven by the motor;
a- the toothed part has one of its inter-tooth faces inclined in relation to the other face;
b- the toothed part has one of its inter-tooth faces appreciably radial;
17- The means of manoeuvre comprises a thread whose direction of thread is such as to allow the closing of the jaws when the spindle is driven normally by the motor and the means of manoeuvre immobilised.
18- The machine tool comprises an immobilisation device under rotation either of the spindle or the means of manoeuvre, with this immobilisation device only coming into operation temporarily when the tool clamping device and/or the tool casings are manoeuvred.
a- the immobilisation device comprises a lever whose extremity possesses at least one tooth engaging in the inter-tooth spaces of the toothed part of the spindle or of the means of manoeuvre;
b- the immobilisation device comprises a catch with at least one tooth which cooperates with the ratchet wheel which forms the toothed part of the spindle or the means of manoeuvre, with this catch being maintained in the engaged position by an interchangeable or adjustable calibrated spring;
c- the lever or the catch comprise an extension opposed to its tip and intended to control its engagement;
d- the immobilisation device comprises a brake such that a friction taper rests or grips the element to be immobilised;
e- the immobilisation device comprises an elastic washer or a resting spring interposed between this device and its control element;
19- The immobilisation device comprises a means of retaining in at least one operating position: rest and engaged;
a- the immobilisation device is stopped by a bearing which, when pushed by a spring, partially engages in holes of this device;
b- the immobilisation device is stopped by a plate or leaf spring the free extremity of which engages in hollows or holes of this device;
c- the immobilisation device is mounted on its axis with one elastic braking washer.
20- The immobilisation device or devices are placed on a mobile element , such as a sliding plate, allowing simultaneously the engagement of this device or these devices when this mobile element is actioned by a mechanical, electromagnetic means etc ...
21- The immobilisation device comprises for its feeding an articulated cam, preferably on the extension of the lever or the catch, with this cam rolling on a turning part driven directly by the motor and actioning the immobilisation device when this motor turns in reverse.
22- The immobilisation device comprises a control button and a liaison shank to the motor direction inverter in a manner that the engagement of this device compulsorily sets the inverter to the reverse direction position.
23- The tool casings comprise a centring means in a manner that their axes coincide with that of the spindle, this centring means co-operating with the fixing device of these casings;

a-the centring and the fixing of the tool casings are ensured by fixing pads situated on the one plane orthogonal to the axis of the tools and directed, preferably, towards the interior, with these pads coming to place themselves and centre themselves in the cavities of the casing of the spindle which are themselves situated on one plane orthogonal to the axis of the spindle.
b- the tool casings comprise a bore coming to place itself on a cylindrical machined part on the spindle casing and concentric to the axis of the spindle.
24- The tool casings fixing device is situated between the two bearings of the spindle and partially in the interior of the casing of the spindle.
25- The tool casings fixing device comprises a means of manoeuvre linked to that of the tool clamping device;
a- the tool casings fixing device is directly controlled by the reaction of the immobilisation device of the spindle or the means of manoeuvre which is articulated on one of the elements of the said fixing device.
26 – The fixing device of the tool casings is realised by a fixing ring concentric to the spindle and mobile around the latter;
a- the fixing ring is situated at the front and at a distance from the bottoms of the cavities of the spindle casing appreciably equal to the thickness of the fixing pads of the tool casings;
b- the fixing ring comprises at least two bolts cooperating with the fixing pads of the tool casings for their fixing, and at least two disengagements allowing the said pads to pass to be freed;
c- the bolts are obtained directly by cutting with the fixing ring and possess one extremity rendered elastic by a partial slit;
d- the fixing ring comprises at least one rear shoulder which comes to place itself the extremity of a blocking lever to prevent it rotating;
e- the blocking lever recalled by a spring is controlled by an external button and is articulated, preferably, on one of the fixing screws of the front casing of the spindle;
27- The fixing device of the tool casings is assured by lock bolts sliding radially in the spindle casing;
a- the bolts are realised by bearings whose radial displacement is controlled by a multiple cam concentric to the spindle and mobile around the latter;
b- the lock bolts engage for the bolting of the tool casings in an interior circular groove of the latter.
28- The immobilisation device, such as the catch, articulated on one of the elements of the tool casing fixing device, comprises a point which cooperates with a spindle casing boss in a manner to prevent it disengaging when the tool casing fixing device is opened and to bolt the latter in the closed position.
29- The tool casings possess at least one centring bore to guide with a sufficiently broad free-play the axes of their tools or their tool holders;
a- the bore has a taper such that the tip of the taper is placed opposite the clamping device;
b- the axes of the tools or tool-carriers of the tool-casings have a cylindrical tail with a diameter that is slightly smaller to that corresponding to the maximum capacity of the clamping device of the machine and one extremity of this tapered tail.
30- The spindle (or its drive motor) is coupled to an interruption device associated to a revolutions counter or a reference screw setting the endpoint of the releasing or tightening of tools and cutting the power supply to the drive motor.

Translated from French

31- The drive motor is equipped with a direction inverter, with the inverse of the normal direction preferably used to effect the opening of the clamping device, and a voltage, output or pressure limiter depending on the power source used, thus ensuring a limitation of the speed and/or release or closing torque.

32- The released tools are recovered to an empty plate while the new or resharpened tools are positioned on another plate for presenting to the machine, with these two plates circulating in succession on the work bench between the pieces to be machined and comprising a feeder to initiate the manoeuvring of spindle clamping devices.

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